INVESTIGATION OF THE SUBSURFACE WATER QUALITY AND FILL MATERIAL AT THE FEDERAL MARINE TERMINALS SITE RIVERVIEW, MICHIGAN

Federal Marine Terminals, Inc.
Riverview, Michigan

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INTRODUCTION

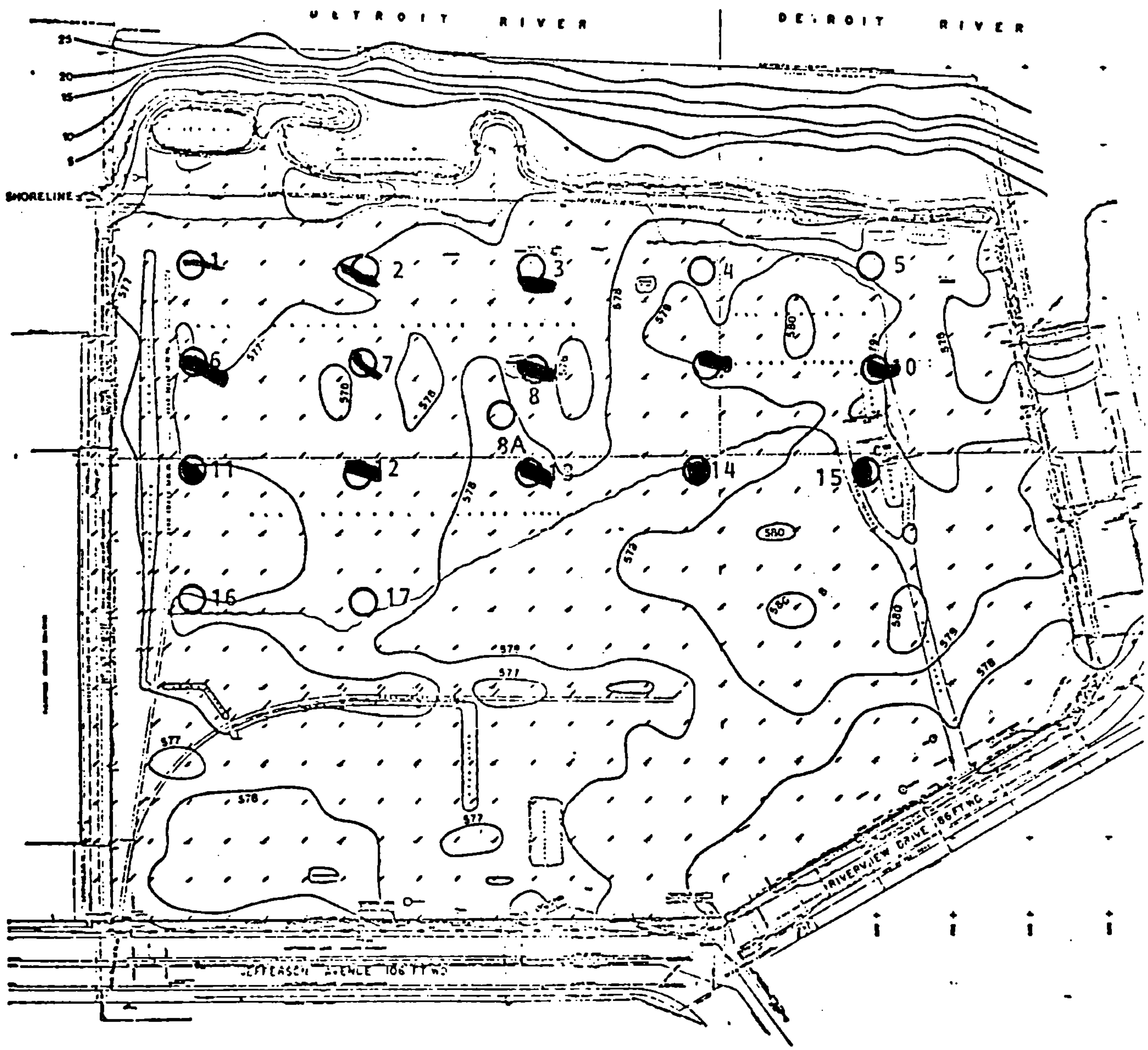
This report presents the findings of a study undertaken to describe the nature and extent of subsurface chemical contamination at the Federal Marine Terminals construction site in Riverview, Michigan. The study deals with the chemical analysis of subsurface water as well as a physical description of soil and fill materials on the site.

Site location and other site details may be found in an Environmental Assessment prepared for Federal Marine Terminals, Inc. The site is a thirty acre parcel located adjacent to the Detroit River just north of the Grosse Ile Toll Bridge. The City of Riverview boat launching area is immediately south of the property. Approximately half of the total area is covered with rocky, limestone fill and it is this area of the site which was intensively studied during this investigation.

METHODOLOGY

Subsurface Water Sampling - On December 12 and 13, 1979, subsurface water samples were collected by using a backhoe to excavate an approximately ten foot by ten foot hole at fifteen (15) locations on the site. At sampling sites nos. 10 and 15 a sewer-line trench excavated that day was used. Approximate sampling locations are shown in Figure 1. The depth of each excavation was variable but was always deep enough so as to contact the original soil underlying the fill material. In most cases this was a silty clay or an organic silt.

With the exception of sampling sites 16, 15, and 10, samples were collected of the water pouring from the face of the excavation at each sampling location. Fiberglass awning wrapped in aluminum foil was inserted into the face of the excavation immediately



Topography
and
River Bottom Contours

Figure 1. Approximate locations of sampling locations at the Federal Marine Terminals site, Riverview, Michigan.

below the location from where water was entering the sampling pit. The awning acted to prevent the stream of water from running down the face of the excavation pit wall, thus minimizing contamination of the water sample by the fill material. Furthermore, ponded surface water in the vicinity of each sampling location was prevented from entering the excavation by building small dikes. This prevented contamination of subsurface water samples with surface water on the site. From the stream of water collected on the aluminum foil covered awning, a one gallon glass jug and a one liter polyethylene bottle were filled. During the water collection procedure careful attention was paid to insure that sediment and/or fill material did not contaminate the water sample. Water samples were returned to cardboard boxes and carried from sampling location to sampling location or returned to a nearby locked automobile. Samples were not stored on ice as the ambient air temperature was quite cool and refrigeration was considered unnecessary.

At sampling locations 16, 15 and 10, the rate of water seepage from the excavation wall was not sufficient to allow for a water sample to be collected. At sampling locations 14 and 8A, Michigan Department of Natural Resources personnel collected samples of subsurface water. BASF/Wyandotte Corporation personnel also obtained water samples at each subsurface sampling location where water samples were collected.

Subsurface Soil/Fill Sampling - At each sampling location, samples were taken of various strata of solid material revealed by the excavation operation. Whenever a sample was collected, the distance below existing grade and its physical character were recorded. In addition, the thickness of each stratum and depth below the surface were also recorded. Samples of fill materials were obtained from the excavation wall with a pen knife or screwdriver, placed in glass bottles, and stored in a manner similar to the water samples. As with the water samples, BASF/Wyandotte Corporation personnel received samples of each stratum sampled.

Water Analysis - All water samples were delivered the same day of collection to Canton Analytical Laboratories for chemical analysis. The water quality constituents measured and the analytical methods employed are summarized in Table 1.

RESULTS

Subsurface Water Quality - Results of chemical analyses of water samples from each sampling location are presented in Appendix A. Except for sample location no. 14

Table 1

Summary of Constituents Measured and Analytical Methods Employed in the Study of Subsurface Conditions at the Federal Marine Terminals Site

Constituent	Method
pH	Electrometric
COD	Refuls, titrimetric
BOD	Winkler, five day
TOC	Beckman Carbon Analyzer
Grease and Oil	Freon, gravimetric
Methylene Blue Active Substances	American Public Health Association
Total Solids	Gravimetric, 103°C
Suspended Solids	Gravimetric
Volatile Solids	Gravimetric, 550-600°C
Total Phosphorus	Persulfate digestion, dilution and blank compensation, colorimetric
Total Kjeldahl Nitrogen	Digestion, distillation, Nesslerization
Ammonia	Distillation, Nesslerization
Sulfate	Dilution, blank compensation, turbidimetric
Sulfide, Total	Precipitation by zincacetate, washing colorimetric
Cyanide	Reflux with airtrain, $AgNO_3$ titrimetric
Arsenic Selenium	Digestion with H_2O_2, Nickel Nitrate, Furnace
Antimony Aluminum Beryllium	Furnace
Remaining metals (Cd, Cr, Co, Cu, Pb, Hg, Ni, Ag, and Zn)	HNO_3 digestion, dissolution with HCI, Flame (USEPA March, 1979)
Organic chemicals	GC/MS for base/neutral extractable compounds with a 6' 2% OV-17 chromatography column; for acid extractable compounds with a 3' SP 1240DA column; for purge and trap compounds a 6' 0.2% carbowax 1500 column

all of the subsurface water samples were dark brown, slippery, and the water foamed readily. The color intensity was sufficient to render the water samples opaque. Many water samples had a chemical/petroleum odor, but a visible sheen of oil was not observed in any water sample nor was there any phase separation of the type observed when mixing oil and water.

The subsurface water quality at the Federal Marine Terminals site is extremely poor (Table 2). Three bases for comparison of inorganic water quality constituents are provided; Wayne County Metropolitan Sewerage System regulations for the discharge of wastewaters into public sewers, U.S. Environmental Portection Agency National Interim Primary Drinking Water Regulations, and U.S. Environmental Protection Agency Quality Criteria for Water. Based on the Wayne County Metropolitan Sewerage System regulations, the subsurface water is unacceptable for discharge to the treatment facility because of excessive levels of chemical oxygen demand (COD), biological oxygen demand (BOD), grease and oil, total solids, suspended solids, total phosphorus, cyanide, aluminum, antimony, lead, mercury, and silver. In addition, the pH of the subsurface water exceeds the limits for discharge to the public sewer established by Wayne County personnel. The subsurface water at the site is also not acceptable for discharge to the Detroit Wastewater Treatment facility, a somewhat more advanced treatment facility than Wayne County, because of high levels of cyanide, lead and mercury.

If the subsurface water is unsuitable for discharge to a wastewater treatment facility, it is also likely that the water is not suitable for human consumption or discharge to a receiving body of water such as the Detroit River. Table 2 shows that the subsurface water quality, as judged by the mean of the individual sampling locations, violates the drinking water standards for every parameter except zinc and copper. In particular, the average concentration of cyanide, lead and mercury exceed the permissible levels of these elements in drinking water. A third basis by which to judge the subsurface water quality is by comparison to criteria which reflect the impact of water constituents and pollutants on aquatic life (USEPA, 1976). These criteria are summarized in Table 2 under the category freshwater aquatic life. The average of all sampling locations exceeds the water quality criteria for every constituent except arsenic and beryllium. In fact, un-ionized ammonia and cyanide concentrations in the subsurface water are sufficient to kill most fish (USEPA, 1976).

Table 2. Summary of Subsurface Water Chemistry on December 12-13, 1979 at Federal Marine Terminals Site.

	Federal Marine Data Range (mg/l)	Mean	Wayne County Wastewater Limit (mg/l)	Drinking Water Standard (mg/l)	Freshwater Aquatic Life (mg/l)
HEAVY METALS					
Cadmium	<0.1-0.6	0.14	2.0	0.01	0.01
Total Chromium	<0.1-0.9	0.34	5.0	0.05	0.10
Chromium, hexavalent	<0.1-0.4	0.17	3.0		
Aluminum	0.4-76	16.0	1.0		
Antimony	<0.1-9.0	2.3	1.0		
Beryllium	<0.05	<0.05	0.01	NS	1.10
Cobalt	<0.01-2.4	0.73		NS	
Copper	<0.1-2.4	0.66	2.0	1.0	0.05-0.10
Lead	0.3-6.8	2.7	1.0	0.05	
Mercury	0.01-2.5	0.870	0.002	0.002	0.00005
Nickel	<0.01-5.3	1.8	3.0	NS	0.10
Selenium	0.06-0.55	0.27	1.0	0.010	0.025
Silver	<0.1-0.8	0.27	0.05	0.05	
Zinc	<0.1-2.9	0.94	5.0	5.0	

NS = No standard established as yet.

Table 2. Summary of Subsurface Water Chemistry on December 12-13, 1979 at Federal Marine Terminals Site.

	Federal Marine Data (mg/l) Range	Mean	Wayne County Wastewater Limit (mg/l)	Drinking Water Standard (mg/l)	Freshwater Aquatic Life (mg/l)
pH	7.4-12.4	10.8	6.5-8.0	5-9	6.5-9.0
COD	335-11800	3,990	600		
BOD	300-4900	3,030	300		
TOC	66-7000	2,100			
Grease and Oil	40-11,600	3,480	25	15	0.01
MBAS	1-4000	385			
Total Solids	4900-197,000	52,300	2000		
Suspended Solids	10-3810	1,340	350		
Volatile Solids	560-101,000	19,200			
Total Phosphorus (as P)	<0.03-84.8	18.8	13		
Total Kjeldahl N	4-300	82			
Ammonia	<0.1-97.2	24.2			0.02 (un-ionize
Sulfate	240-4300	1600		250	
Sulfide	<1.0	<1.0	10		
Cyanide	<0.1-58.8	14.7	1.0	0.20	0.005
Arsenic	<0.05-0.30	0.10	0.1	0.05	0.10

NS = No standard established as yet.

The results of chemical analyses of water samples from each sampling location are presented in Appendix A.

The analysis of water samples for organic chemicals revealed that, in addition to contamination by heavy metals and other water quality constituents, many of the water samples were contaminated by organic chemicals (Table 3). These results show that a wide range of organic compounds are found in the water in a wide range of concentrations. Phenol, napthalene, and anthracene were the most common contaminants in the subsurface water. Phenol was detected in thirteen of the sampling locations, while napthalene and anthracene were detected in twelve and ten locations, respectively (Table 3). However, some other chemicals were detected at only one sampling location. A total of thirty organic chemicals on the EPA Priority Pollutant ~~list were~~ detected in water samples from the site. Of the locations sampled on the site, the largest number of organic chemicals and, generally, the highest concentrations of these chemicals were found at locations no. 7 and no. 8. The next highest level of organic contamination was found at locations no. 12 and no. 2, particularly with regard to the organic chemicals napthalene, anthracene, and pyrene.

Unlike the water quality constituents discussed previously, there are few criteria with which to judge the severity of the organic chemical contamination of the site. Table 3 presents preliminary concentrations for some compounds which have been recently promulgated by the USEPA for public comment. As before, there are several bases by which a comparison may be made. A comparison to drinking water standards presented in Table 3 shows that concentrations in organic chemicals in subsurface water exceed the recommended levels for several constituents. Specifically, mean concentrations of chloroform, 1,2-dichloroethane, benzene, chlorobenzene, 2-chlorophenol, 2-nitrophenol, 2,4-dichlorophenol, 4,6-dinitro-o-cresol, pentachlorophenol, napthalene, acenaphthene, and fluoranthene exceed the proposed drinking water standards promulgated in 1979 by the USEPA.

Another basis for comparison is a set of criteria established for the protection of freshwater aquatic life and proposed for comment by the USEPA. This set consists of two criteria for each chemical; one number represents the concentration limit for twenty-four hour exposure and the second number represents a maximum exposure concentration. Using these guidelines, the mean concentrations of 2-chlorophenol, 2,4-dimethylphenol, 2,4-dichlorophenol, pentachlorophenol, and acenaphthene exceed the recommended levels for both the average twenty-four hour exposure and the maximum limit.

Table 3

Summary of Organic Chemicals on the U.S. EPA Priority Pollutant List Detected in Subsurface Water Samples on December 12-13, 1979 at the Federal Marine Terminals Site

All Values in µg/l

Chemical	Number of Locations	Rance	Mean	U.S. EPA Criteria* Freshwater Aquatic Life 24 hr. Avg.	Freshwater Aquatic Life Maximum Limit	Drinking Water
chloroform	7	5-44	16	500	1,200	2
1-2-dichloro-ethane	3	50-340	175	3,900	8,000	0.7-7.0
1,2-dichloro-propane	3	86-195	135	920	2,100	200
1,1,1-trichloro-ethane	6	9-104	30	5,300	12,000	15,700
tetrachloro-ethylene	5	11-62	25	NA	NA	NA
benzene	6	1-840	157	3,100	7,000	0.15-15
toluene	2	550-2480	1515	2,300	5,200	17,400
ethylbenzene	4	44-275	117	NA	NA	NA
chlorobenzene	2	13-1100	557	1,500	3,500	20
2-chlorophenol	4	8-615	168	60	180	0.3
2-nitrophenol	2	70-115	93	2,700	6,200	68.6
phenol	13	15-3000	534	600	3,400	3,400
2,4-dimethyl-phenol	8	5-465	109	38	84	NA
2,4-dichloro-phenol	2	10-660	335	0.4	110	0.5
trichlorophenol	4	5-1010	270	52	150	NA
p-chloro-m-cresol	4	15-145	75	NA	NA	NA

Table 3 (continued)

Summary of Organic Chemicals on the U.S. EPA
Priority Pollutant List Detected in Subsurface Water
Samples on December 12-13, 1979 at the Federal Marine Terminals Site

All Values in μg/l

Chemical	Number of Locations	Range	Mean	U.S. EPA Criteria* Freshwater Aquatic Life 24 hr. Avg.	Freshwater Aquatic Life Maximum Limit	Drinking Water
4-6-dinitro-o-cresol	1	-	35	NA	NA	12.8
pentachloro-phenol	9	80-1300	458	6.2	14	140
4-nitrophenol	5	25-145	70	NA	NA	NA
naptholene	12	40-27,000	3723	NA	NA	143
anthracene	10	90-13,300	2869	NA	NA	NA
pyrene	6	230-10,500	3942	NA	NA	NA
acenaphthylene	7	170-4200	1071	NA	NA	NA
fluorene	6	75-2550	758	NA	NA	NA
chrysene	1	-	150	NA	NA	NA
acenephthene	4	125-1450	579	110	240	20
fluoranthene	2	1115-2445	1780	250	560	200
dichlorobenzene	1	-	125	NA	NA	NA
di-n-octyl phthalate	2	100-300	200	NA	NA	10,000
dibutyl phthalate	1	-	160	NA	NA	5,000

*From U.S. EPA Water Quality Criteria. Federal Register, vol. 44, no. 52, p. 15926, March 15, 1979; Federal Register, vol. 44, no. 144, p. 43660, July 25, 1979; Federal Register vol. 44, no. 191, p.56228, October 1, 1979.

NA=No available information at this time.

Subsurface Soil/Fill - The character of various strata at the site is summarized in Table 4 and photographs of each pit are in Appendix B. The subsurface conditions are very heterogeneous with considerable variation in the character of subsurface strata as well as the thickness of these strata. This variation precludes the description of a typical excavation profile, but certain general remarks are possible. All of the sample excavations contained at least one stratum of solid material which did not resemble a natural soil and which appeared to be a chemical waste product. In many excavations, several different strata of solid material were distinguished. These strata were generally sharply delineated so that an observer could clearly perceive where the strata changed character. With only one exception, the excavations revealed the original soil (either an organic silt or a silty clay) which was buried by the fill operations over the past years.

Although there was considerable variation in the layering of solid material among the sampling locations, all of the non-soil material had been covered either by limestone cobble, clay or sandy gravel. This soil cover ranged in thickness from six inches to nearly six feet. Below this soil cover many different strata were revealed, but the most common strata were a black cinder layer with large stones that resembled asphalt but was not as hard, and a gray-white layer which had a consistency of lard or shortening. The excavations in the southern and western portions of the site tended to have the fewest strata, while those in the northeastern portion near the Detroit River had the greatest number of strata.

In addition to the strata exposed during excavation, several different types of material were unearthed. In several sampling areas, particularly in the northeastern area, metal containers ranging in size from five gallon cans to fifty-five gallon drums were uncovered. These containers were generally intact and filled with solid or liquid substances. In samplng location no. 5 a large fifty-five gallon cardboard barrel of solid material resembling stiff resin was unearthed. Other materials uncovered during the excavation of the sampling pits were large paper bags with Wyandotte labels, building bricks and timbers, large solid blocks of inorganic salts, wooden oil skimmer, graphite electrodes, bottles, oil shale, rubber hoses, plastic bags, and wire ribbons of the type used for shipping cartons.

All of the sampling pits had a chemical odor, although the intensity and character of the odor varied. Location no. 8 clearly had the most intense odor with a character very similar to coke oven wastes. In other

Table 4

Summary of Subsurface Soil/Fill Conditions at the Federal Marine Terminals Site, Riverview, Michigan

Sample Location	Depth (in)	Description
[redacted]	0-16	brown sandy clay
	16-48	white stiff solid waste
	48-57	brown clay
	57-66	gray-white so[redacted]ste
	66-88	black sandy silt
2	0-30	brown sandy clay
	30-39	gray-white solid waste
	39-43	black cinder layer with large rocks
	43-47	white stiff [redacted]aste
	47-56	reddish brown solid waste
3 North Wall	0-58	sandy gravel
	58-80	black cinder layer with large rocks
	80	organic silt
[redacted]	0-47	sandy gravel
	47-68	gray-white solid waste
	68-78	black cinder with large rocks
	78	organic silt
4	0-25	sand
	25-31	gray-white solid waste
	31-68	black cinder layer
	68-75	gravel and clay
	75	organic silt
5	0-68	sandy gravel
	68-82	black cinder layer
	82-88	gray brown silty clay
	88	gray clay

Table 4 (continued)

Summary of Subsurface Soil/Fill Conditions at the

Federal Marine Terminals Site, Riverview, Michigan

Sample Location	Depth (in)	Description
[redacted]	0-12	limestone cobble
	12-48	stiff clay
	18-48	black cinder with stones, rubble and [redacted]
	48	organic silt
[redacted]	0-16	stiff gray-brown clay
	16-24	black cinder with large stones
	24-34	gray-white so[redacted]aste
	34-40	stiff white so[redacted]ste
	40-48	gray-white [redacted]te
	48	organic silt
[redacted]	0-8	limestone cobble
	8-20	black cinder with large stones
	20-28	tan sandy clay
	28-40	black cinder with trash and rubble
	40-55	gray-white s[redacted]aste
	55-65	stiff white sol[redacted]ste
	66	organic silt
[redacted]	0-26	very hard "cement" layer
	26-32	stiff black layer
	32-38	stiff gray s[redacted]
	38-46	stiff tan to brown with stones
	46-96	gray-white solid waste with trash
	96	organic silt
[redacted]	0-49	gravelly clay covered with sand
	49-70	gray-white s[redacted]te

Table 4 (continued)

Summary of Subsurface Soil/Fill Conditions at the Federal Marine Terminals Site, Riverview, Michigan

Sample Location	Depth (in)	Description
[redacted]	0-12	limestone cobble
	12-30	stiff gray clay
	30-40	black sandy clay
	40-60	black cinders with [redacted]
[redacted]	0-12	stiff gray clay
	12-16	black cinder with stones
	16-26	stiff black layer with stones
	26-38	gray-white [redacted] waste
	38-60	loose bluish [redacted]
	60	organic silt
[redacted]	0-6	limestone cobble
	6-12	brownish black uniformly sized particles
	12-24	sandy gray clay
	24-55	gray-white [redacted] with bricks
	55	organic silt
[redacted]	0-12	tan sand
	12-18	brownish sand
	18-40	[redacted]
	40-50	[redacted]
	50	organic silt
[redacted]	0-19	sandy clay
	19-24	gray-brown clay
	24-32	[redacted]
	32-47	[redacted]
	47	organic silt

Table 4 (continued)
Summary of Subsurface Soil/Fill Conditions at the
Federal Marine Terminals Site, Riverview, Michigan

Sample Location	Depth (in)	Description
16	0-6	limestone cobble
	6-24	black cinders with stones
	24-48	tan sandy gravel
	48	organic silt
17	0-6	limestone cobble
	6-15	gray-white solid waste
	15-45	black cinder with fine sediment

sampling locations the odor was less strong and different in character, sometimes smelling of ammonia or phenol.

DISCUSSION

The subsurface water quality is extremely poor and is highly contaminated with cyanide, grease and oil, heavy metals, inorganic chemicals and organic chemicals. Many of the contaminants detected in the water analysis are widely recognized as toxic, or organoleptic and the concentrations of these chemicals are in excess of several different water quality criteria such as drinking water standards, water quality criteria for the protection of freshwater aquatic life, and discharge requirements to public sewers. It is not within the scope of this study to discuss whether the water at the site represents a human health hazard, but many freshwater aquatic organisms would be killed if exposed to the subsurface water at the Federal Marine Terminals site.

The excessively high concentrations of several water quality constituents and the presence of subsurface strata of a chemical origin indicate that the site has been used for the open disposal of chemical and/or industrial waste products. Furthermore, high concentrations of grease and oil and other contaminants in the water suggest that open disposal of liquid wastes may also have occurred in the past. Finally, the unearthing of stainless steel fifty-five gallon drums, dry chemical bags, and other rubble related to industrial chemical operations further suggests that the site was used as a dump for rubbish generated by an industrial activity of a chemical nature.

Some of the subsurface strata found at the site were building rubble, timbers, bricks, and other materials considered clean fill. However, clean fill generally composed a smaller fraction of the total fill examined than the chemical/industrial material.

The source of the chemical contamination of the subsurface water cannot be accurately determined without further study. However, the concentrations of pollutants and the variety of contaminants detected at the site eliminate the hypothesis that the contamination is due to natural causes. The concentrations of pollutants, particularly the heavy metals and organics, detected in the subsurface water are in excess of levels detected in natural waters in the surrounding area. For instance, at a sampling station in the Detroit River near the northern end of Grosse Ile the average mercury and lead concentration in 1973 and 1974 was 0.9 µg/l and 7.0 µg/l, respectively (USEPA, 1974). Concentrations of these elements in subsurface water at the Federal Marine Terminals site were 870 µg/l for mercury and 2700 µg/l for lead. The large discrepancy between these values precludes developing a hypothesis that the subsurface contamination at the Federal Marine Terminals site is the result of flooding of the site by the Detroit River.

Similarly, based upon the existing data base it would appear that the contamination at the Federal Marine Terminals site is not due to subsurface movement of water into the site from the surrounding area. The site is bordered by an apparently continuous layer of clay to the west (Federal Marine Terminals, 1979) and, several pits dug along the northern edge of the site also revealed impermeable soil types. The presence of these impermeable soils suggests that subsurface water is not flowing into the site from land areas, although there may be movement of water into the site from the river.

FINDINGS

- Subsurface water quality is extremely poor with high pH, and high concentrations of COD, TOC, grease and oil, total solids, total volatile solids, total phosphorus, ammonia, sulfate, heavy metals, arsenic, cyanide and organic chemicals.

- Some of the constituents of the subsurface water are widely recognized as toxic or organoleptic.

- Several constituents, including those chemicals considered toxic or organoleptic, are in the subsurface water in concentrations in excess of criteria established for 1) primary drinking water, 2) protection of freshwater aquatic life, and 3) discharge to public sewers.

- The quality of subsurface water and the presence of fill strata of a chemical or industrial origin, fifty-five gallon stainless steel drums, discarded glass bottles, and other discarded material related to industrial operations indicate that the site has been used as a chemical and industrial waste dump site.

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APPENDIX A.

CHEMICAL ANALYSIS OF SUBSURFACE WATER SAMPLES FROM THE FEDERAL MARINE TERMINALS SITE RIVERVIEW, MICHIGAN

...sis of Water Collected 12
at Riverview, Michigan Site

Site	1-1	2-1	3-1	4-1	5-1
Cyanide, Total	2.9	17.6	17.6	3.5	3.5
C.O.D.	1300	11800	1600	1020	825
B.O.D.	3300	3800	2800	400	300
T.O.C.	450	4050	375	175	275
T.K.N.	95	300	70	43	55
pH	12.2	12.4	10.8	11.6	10.2
Ammonia, Total	5.4	25.5	11.4	8.1	6.6
Phosphorous, Total (as PO_4)	0.9	31.0	10.0	6.0	1.6
Grease & Oil	179	11600	580	80	50
M.B.A.S.	20	300	100	100	60
Sulfide, Total	<1	<1	<1	<1	<1
Sulfate, Total	500	3400	500	500	240
Total Solids	11900	72300	25600	15300	25000
Total Suspended Solids	490	110	430	<10	450
Total Volatile Solids	1700	34700	2400	1900	2200
Aluminum	76.0	15.0	1.0	0.4	5.0
Antimony	2.1	0.9	<0.1	<0.1	3.1
Arsenic	0.3	0.3	0.1	0.08	0.05
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	0.2	<0.1	<0.1	<0.1	0.6
Chromium, Total	<0.1	0.3	0.1	<0.1	0.4
Chromium, Hexavalent	<0.1	0.1	<0.1	<0.1	0.2

*All results in mg/l

Site	1-1	2-1	3-1	4-1	5-1
Cobalt	0.1	1.0	0.7	0.2	0.4
Copper	0.3	0.2	0.3	<0.1	0.2
Lead	1.5	0.6	1.1	0.5	0.5
Mercury	0.16	1.6	0.18	0.25	0.02
Nickel	1.2	2.0	0.4	0.4	1.3
Selenium	0.06	0.30	0.30	0.12	0.15
Silver	0.2	0.2	0.2	0.1	0.2
Zinc	<0.1	0.5	0.2	0.2	<0.1

*All results in mg/l

Site	6-110-F	7-1	8-1	9-1	11-109-F
Cyanide, Total	26.5	58.8	41.9	2.8	3.7
C.O.D.	4960	6420	7600	740	8500
B.O.D.	3300	4600	4900	300	3800
T.O.C.	2800	3200	7000	100	4500
T.K.N.	250	47.5	59	12.3	122
pH	10.2	11.3	10.8	11.8	10.9
Ammonia, Total	37.2	40.2	28.5	4.8	97.2
Phosphorous, Total (as PO_4)	260	87	150	3.7	102
Grease & Oil	9100	6300	9900	130	3000
M.B.A.S.	60	600	4000	150	1.1
Sulfide, Total	<1	<1	<1	<1	<1
Sulfate, Total	2700	3800	4300	250	3300
Total Solids	108,000	38,400	71,900	10,900	197,000
Total Suspended Solids	3810	3140	840	25	3310
Total Volatile Solids	21,600	8500	14,300	2300	101,000
Aluminum	22	30	3.3	0.5	31
Antimony	0.9	0.1	6.3	0.2	9.0
Arsenic	0.06	0.1	0.12	0.08	0.10
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	<0.1	<0.1	<0.1	<0.1	0.1
Chromium, Total	0.9	0.7	0.3	<0.1	0.8
Chromium, Hexavalent	0.4	0.3	0.1	<0.1	0.4

*All results in mg/l

Site - - - - - - - - -	6-110-F	7-1	8-1	9-1	11-109-F
Cobalt	1.6	0.9	1.3	<0.1	2.4
Copper	1.3	0.9	1.0	<0.1	1.5
Lead	3.8	2.5	5.6	0.2	6.2
Mercury	0.10	2.5	2.0	0.22	2.1
Nickel	5.3	2.0	3.0	0.4	4.9
Selenium	0.50	0.25	0.50	0.10	0.55
Silver	0.7	0.4	0.4	0.1	0.8
Zinc	1.8	2.6	1.8	<0.1	1.9

*All results in mg/l

ples collected 12-12-79
e 5

	12-1	13-1	14-1	14-2	171
nide, Total	1.5	4.4	<0.1	1.1	35.3
O.D.	4200	4440	335	890	5150
.D.	3000	4200	300	300	4100
).C.	1800	3000	66	125	3600
K.N.	24.0	49.0	4.0	8.1	93.0
	12.0	10.4	7.4	9.1	10.8
	19.5	18.0	0.36	<0.1	60.0
nmonia, Total	105	47	1.9	<0.1	57
osphorous, Total (PO_4)	3400	3400	40	980	3500
rease & Oil	60	60	3.0	20	250
B.A.S.	<1	<1	<1	<1	<1
lfide, Total	550	1300	1000	600	1100
lfate, Total	20,100	45,200	6800	4900	130,800
tal Solids	2040	2020	1300	590	1580
tal Suspended Solids	5400	14,900	1200	560	75,000
otal Volatile Solids	6.3	3.5	8.0	3.8	36.0
luminum	2.5	7.0	0.8	0.5	0.9
ntimony	0.05	<0.05	<0.05	0.06	<0.05
rsenic	<0.05	<0.05	<0.05	<0.05	<0.05
eryllium	<0.1	<0.1	<0.1	<0.1	<0.1
admium	<0.1	0.3	<0.1	<0.1	0.7
hromium, Total	<0.1	0.1	<0.1	<0.1	0.3
hromium, Hexavalent					

*All results in mg/l

...te	12-1	13-1	14-1	14-2	171
Cobalt	0.3	0.5	<0.1	<0.1	1.3
Copper	0.5	0.5	0.4	0.2	2.4
Lead	5.4	3.5	1.5	0.3	6.8
Mercury	1.4	0.45	0.03	0.01	2.1
Nickel	1.0	1.5	0.2	<0.1	3.5
Selenium	0.12	0.30	0.15	0.20	0.45
Silver	0.10	0.20	<0.1	<0.1	0.5
Zinc	0.8	1.7	<0.1	<0.1	2.9

*All results in mg/l

CANTON ANALYTICAL LABORATORY

By: Peter W. Rekshan

Peter W. Rekshan
Laboratory Director

BASE/NEUTRAL SAMPLES - CONCENTRATION (μgr/liter : PPB)

Sample	Naphthalene	Anthracene	Pyrene	Acenaphthylene	Fluorene	Di-n-octyl phthalate	Chrysene	Dichlorobenzene	Acenaphthene	Dibutyl phthalate	Fluor
1	45	90	230	—	—	—	—	—	—	—	-
2	4000	5000	4500	250	75	—	—	—	—	—	-
3	60	110	—	—	—	100	—	—	—	—	-
4	40	—	—	—	—	—	—	—	—	—	
5	—	—	—	—	—	—	—	—	—	—	-
6	450	435	—	170	215	—	—	125	150	160	-
7	1900	1150	1050	315	170	—	150	—	125	—	11[illegible]
8	27,000	13,300	10,500	4200	2550	—	—	—	1450	—	-
9	60	—	—	—	—	—	—	—	—	—	-
11	145	425	—	—	—	—	—	—	—	—	-
12	10,250	6375	5000	2100	1250	—	—	—	590	—	-
13	290	260	—	110	—	—	—	—	—	—	-
14-1	—	—	—	—	—	—	—	—	—	—	-
14-2	—	—	—	—	—	300	—	—	—	—	
17	435	1540	2370	350	285	—	—	—	—	—	4[illegible]

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The following compounds were also detected:

Base-Neutral Extracts

Sample 1	Terpene
Sample 2	Terpene hydrocarbon oil
Sample 3	Terpene
Sample 4	Terpene
Sample 5	Terpene
Sample 6	Terpene
Sample 7	hydrocarbon oil Terpene
Sample 8	Terpene methylnaphthalene
Sample 9	Terpenes
Sample 11	Alcohols
Sample 12	Terpene
Sample 13	Oils Terpene
Sample 17	Terpene Alcohols

ACID EXTRACTABLE POLLUTANTS, in μg/liter (ppb)

Sample	2-chlorophenol	2-nitrophenol	phenol	2,4-dimethyl-phenol	2,4-dichloro-phenol	trichloro-phenol	p-chloro-m-cresol	2,4-dinitro-phenol	4,6-dinitro-o-cresol	pentachloro-phenol	4-nitrophenol
1	—	—	70	25	—	—	—	—	35	215	25
2	—	115	535	100	—	—	—	—	—	1300	—
3	—	—	430	170	—	—	—	—	—	—	95
4	—	—	40	10	—	—	—	—	—	100	—
5	—	—	50	—	—	—	—	—	—	290	—
6	—	—	25	—	—	—	—	—	—	—	—
7	615	70	1950	85	660	1010	70	—	—	690	145
8	35	—	3000	465	—	40	145	—	—	1120	—
9	—	—	15	5	—	—	—	—	—	—	—
11	15	—	535	15	10	25	70	—	—	85	—
12	—	—	50	—	—	—	—	—	—	—	—
13	—	—	85	—	—	5	15	—	—	80	55
14-1	—	—	—	—	—	—	—	—	—	—	—
14-2	—	—	—	—	—	—	—	—	—	—	—
17	8	—	155	—	—	—	—	—	—	240	3

The following compounds were also detected:

Acid Extracts

Sample 1	Cresol Vanillin Phenylacetic acid
Sample 2	Cresol dimethylphenol isomers benzoic acid Lauric acid Palmitic acid Oleic acid
Sample 3	Cresol Phenylacetic acid
Sample 4	Cresol
Sample 7	Cresol dimethylphenol isomers benzoic acid Phenylacetic acid Lauric acid
Sample 8	Cresol Phenylacetic acid Lauric acid Palmitic acid Other acids
Sample 9	Cresol
Sample 11	Cresol Palmitic acid
Sample 13	Benzoic acid Octa sulphur
Sample 17	Cresol Benzoic Acid Phenylacetic acid Octa sulphur

VOLATILES BY PURGE AND TRAP GC/MS, μg/Liter(PPB)

Sample	Chloroform	1,2-dichloroethane	1,2-dichloropropane	1,1,1-trichloroethane	tetrachloroethylene	benzene	toluene	ethylbenzene	chlorobenzene
1	—	—	—	104	—	57	—	—	—
2	13	—	—	—	—	—	—	—	13
3	—	—	—	14	12	—	—	—	—
4	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	
6	13	—	—	15	11	—	—	—	—
7	44	340	195	—	—	77	550	100	—
8	19	134	124	—	62	840	2480	275	1100
9	5	50	—	—	—	10	—	—	—
11	11	—	86	9	25	24	—	44	—
12	—	—	—	—	16	—	—	48	—
13	9	—	—	22	—	—	—	—	—
14-1	—	—	—	—	—	1	—	—	—
14-2	—	—	—	16	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—